

Evaluation of Platelet Indices in Patients with Uncomplicated Essential Hypertension

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Abstract

Introduction: Hypertension is a prothrombotic or hypercoagulable state resulting in platelet dysfunction. Assessments of platelet indices and their bioactivity may be of vital importance for predicting the occurrence and monitoring the progression of hypertension.

Material and Methods: This case control study was conducted on 250 patients with essential hypertension (cases), along with age and sex matched normotensive individuals (controls, n = 100), attending medical OPD of the Department of Medicine, JLN Medical College, Ajmer, over a period of two years. Estimation of blood pressure and platelet indices was done.

Result and Observations: In our study, mean platelet volume (MPV) was 9.26 ± 0.44 fL, mean platelet distribution width (PDW) was 13.62 ± 1.30 fL, mean platelet count was $291.02 \pm 60.40 \times 10^3/\text{mL}$ and mean plateletcrit (PCT) was $0.27 \pm 0.05\%$ in cases group. MPV was 8.11 ± 0.16 fL, mean PDW was 9.94 ± 0.73 fL, mean PLT was $285.88 \pm 60.55 \times 10^3/\text{mL}$ and mean PCT was $0.23 \pm 0.04\%$ in control group. The difference in MPV, PDW and PCT in both groups was found statistically significant. MPV value also increased with increase in grading of hypertension. The association between grading of hypertension and MPV was found statistically significant (p - value <0.01).

Conclusion: MPV, PDW and PCT values are higher in hypertensive patients as compared to controls. MPV has linear correlation with grading of hypertension.

Key words: Blood pressure, mean platelet volume, platelet distribution width, plateletcrit, platelet count,

Introduction

Hypertension is a leading modifiable risk factor for premature death and cardiovascular disease, and a major public health challenge as per World Health Organisation¹.

Hypertension causes target organ damage by direct physical effect of increased blood pressure (BP) as well as the active promotion of atherosclerosis and thrombogenesis^{2,3}. Evidence for a prothrombotic or hypercoagulable state in hypertension has been shown⁴. This may be due, at least in part, to the prothrombotic state associated with inappropriate platelet activation (such as increased aggregation *ex-vivo* and release of soluble P-selectin [sP-selectin])^{5,6}. It has been widely acknowledged that if diagnosis is made at an early stage of hypertension, it can prevent cardiovascular disease and reduce the burden of morbidity and mortality⁷.

Platelet indices comprise platelet distribution width (PDW), mean platelet volume (MPV), plateletcrit (PCT), and blood platelet count (PLT). MPV and PDW are the simple platelet indices, which increase during platelet activation⁸. Mean platelet volume (MPV) is a marker of average platelet size

and activation, and its increased level reflects active large platelets. Some clinical studies have shown that active large platelets contain denser granules, which are metabolically and enzymatically more active than small ones and have a higher thrombotic potential⁹. Increased MPV has been found to be related with mortality after following acute myocardial infarction and re-stenosis¹⁰, and this finding has been reported with hypertension in the background¹¹. There is evidence from both retrospective and prospective studies supporting the validity of MPV as a marker of vascular risk and predictor of thrombotic complications in hypertensive patients^{12,13}.

Likewise, PDW is a simple, practical and specific marker of activation of coagulation, which is used to decide the heterogeneity of platelet size. Several studies have reported that platelet activation has a relationship with cardiovascular morbidity and mortality^{14,15,16}.

Increased platelet activation and aggregation are involved in the pathogenesis of elevated blood pressure. Many researchers have illustrated that the platelet occupies an important position in mediating immune response and maintaining vascular homeostasis, atherosclerosis, and

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inflammation. Moreover, the use of antiplatelet therapies in hypertension supports the hypothesis that platelets play a pivotal role in the pathogenesis. Thus, assessment of platelet indices and their bioactivity may be of vital importance for predicting the occurrence and monitoring the progression of hypertension. Aim of our study was to find the correlation, if any, between various platelet indices with presence of hypertension and with grading of essential hypertension.

Material and Methods

This case-control study was conducted on 250 hypertensive patients and 100 age- and sex-matched normotensive healthy individuals (controls), having age >18 years, attending the Medicine OPD at JLN Medical College Hospital, Ajmer, over a period of two years (January 2020 to January 2022).

Individuals with essential hypertension, both newly diagnosed and established cases, not on treatment or if on treatment, only on Angiotensin-Converting Enzyme inhibitors (ACEI), were included in the study.

Individuals with secondary hypertension, cardiovascular disease, diabetes mellitus, peripheral vascular disease, cerebral infarction, thromboembolic events or on drugs affecting platelet functions or those who have undergone coronary artery bypass surgery, coronary stenting, were excluded.

Information was collected in a pre-designed format from each patient. Consenting patients underwent detailed history, thorough clinical examination and relevant laboratory tests including a Complete Blood Count. Platelet indices were estimated using 3 mL of aseptically collected venous blood in an EDTA coated vial, after an overnight fasting and taken to the central laboratory. The blood sample was aspirated (minimum of 70 microlitre) and diluted to specified ratio and stained. The sample was then fed into flow cells by sheath flow mechanism. PLT, PDW, MPV and PCT were measured by an autoanalyzer (Sysmex XN-1000 made in Japan) via the flow cytometry principle.

In each subject, BP was measured using standard digital sphygmomanometer on two separate occasions at 5 minutes interval, after at least 15-minute restand was then averaged. During this 30-minute proceedings, the participants were required to refrain from smoking or consuming caffeine.

Observations and results

Distribution of subjects has been depicted in Fig. 1. Most of the subjects belonged to 46 - 60 years age group, followed by 61 - 75 years age group.

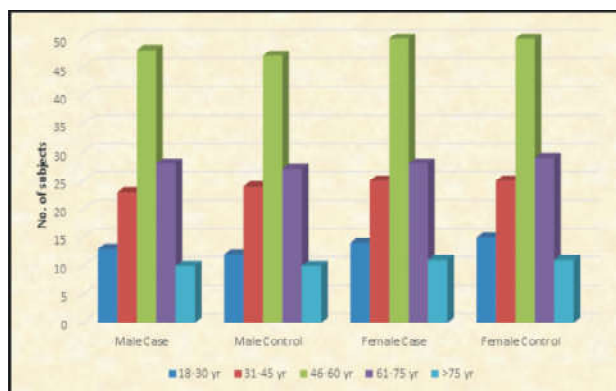


Fig. 1: Showing distribution of cases and controls as per age-groups and gender.

In our study, 51.20% patients were female and 48.80% patients were male.

The mean systolic blood pressure was 170.40 ± 16.99 mm of Hg and mean diastolic blood pressure was 101.08 ± 12.85 mm of Hg among cases. Mean systolic blood pressure was 101.08 ± 12.85 mm of Hg and mean diastolic blood pressure was 69.07 ± 5.78 mm of Hg among controls. Out of the total, 37.20% patients belonged to grade 2 hypertension, 33.60% patients belonged to grade 1 hypertension and 29.20% patients belonged to grade 3 hypertension.

Table I: Showing various platelet indices in cases and controls.

Platelet indices	Cases		Controls		p value
	Mean	SD	Mean	SD	
MPV(fL)	9.26	0.44	8.11	0.16	0.001
PDW(fL)	13.62	1.30	9.94	0.73	0.001
PLT(10^3 /ml)	291.02	60.40	285.88	60.55	0.343
PCT(%)	0.27	0.05	0.23	0.04	0.001

Analysis of various platelet indices showed (Table I) higher value of MPV in patients with essential hypertension (9.26 ± 0.44 fL) when compared with normotensive controls (8.11 ± 0.16 fL) ($p < 0.001$, significant). The mean platelet distribution width was higher in patients with essential hypertension (13.62 ± 1.30 fL) as compared to normotensive controls (9.94 ± 0.73 fL) ($p < 0.001$, significant). The mean platelet count in patients with essential hypertension was 291.02 ± 60.40 per 10^3 /mL and in normotensive controls was 285.88 ± 60.55 per 10^3 /mL (p 0.343, insignificant). Similarly, the mean plateletcrit was also higher in patients with essential hypertension ($0.27 \pm 0.05\%$) when compared with normotensive controls ($0.23 \pm 0.04\%$) ($p < 0.001$, significant).

Table II: Showing association of mean platelet volume and grade of hypertension.

Grade of hypertension	MPV(fL)		p-value
	Mean	SD	
1	8.72	0.10	0.001
2	9.38	0.10	0.001
3	9.73	0.22	0.001

MPV value increased with increase in grade of hypertension. The association between grade of hypertension and MPV was found statistically significant ($p = <0.001$).

Table III: Showing association of platelet distribution width and grade of hypertension

Grade of hypertension	PDW(fL)		p-value
	Mean	SD	
1	13.67	1.25	0.601
2	13.50	1.25	0.601
3	13.68	1.41	0.601

The association between grade of hypertension and PDW was found statistically insignificant ($p = >0.05$).

Table IV: Showing association of platelet count and grade of hypertension.

Grade of hypertension	PLT(10^3 /mL)		p-value
	Mean	SD	
1	295.79	54.54	0.404
2	292.09	64.03	0.404
3	284.15	62.24	0.404

The association between grade of hypertension and PLT was found statistically insignificant ($p = >0.05$).

Table V: Showing association of plateletcrit and grade of hypertension.

Grade of hypertension	PCT(%)		p-value
	Mean	SD	
1	0.26	0.04	0.07
2	0.27	0.06	0.07
3	0.28	0.07	0.07

The association between grade of hypertension and PCT was found statistically insignificant ($p = >0.05$).

Discussion

Concern about the increased prevalence of hypertension has heightened interest to explore an association between

some convenient, and rapidly obtained indices with blood pressure among healthy populations; and we found PDW, MPV and PCT are such indices that correlate with elevated blood pressure levels.

Pathophysiology of elevated blood pressure is multifaceted including vasoconstriction, vascular wall remodelling, and *in situ* thrombosis. Activated platelets may possibly secrete several growth factors and cytokines that influence remodelling of the vessel. Shear forces, the renin-angiotensin system, endothelial dysfunction, elevated catecholamine levels, and the presence of co-morbid conditions promotes the increased activation of platelets in hypertensive patients.

Hypertensive patients exhibit impairment of the autonomic system that includes abnormal parasympathetic and increased sympathetic nervous system activity. The effects of an over-activated sympathetic nervous system on the haemostatic system occur in two ways.

First, platelet activation via alpha2-adrenoreceptor stimulation, which causes shape change and thereby increases MPV.

Second, larger, activated platelets which are sequestered in the spleen can be released into the circulatory system following the elevated levels of adrenaline that contribute to increased MPV levels and heterogeneity (PDW).

In our study, platelet indices, namely mean platelet volume (MPV), platelet distribution width (PDW), platelet count (PLT) and plateletcrit (PCT) were compared between patients with hypertension and persons without hypertension.

Mean platelet volume

MPV is a marker of platelet function and activation. It has been shown that platelet size, measured as MPV, correlates with their reactivity. Larger and hyper-reactive platelets accelerate intracoronary thrombus formation, which leads to a cascade of clinical events, culminating in an acute coronary syndrome.

According to Zheng *et al*¹⁷, larger platelets are more active compared to smaller ones, both metabolically and enzymatically, and are more likely to have a thrombotic potential.

In our study, MPV was higher in patients with essential hypertension (9.26 ± 0.44 fL) when compared with normotensive controls (8.11 ± 0.16 fL) and there was a statistically significant difference between the two groups ($p = <0.001$). Also, mean platelet volume increased with increase in grading of hypertension. The association between grading of hypertension and MPV was found

statistically significant ($p = <0.001$).

Some studies have reported a relationship between MPV and hypertension in different patient groups. Surgit *et al*¹⁸ studied that the MPV levels were significantly higher in resistant hypertension group than in the controlled hypertension and normotensive group ($p = <0.001$).

Güven *et al*¹⁹, found that MPV was significantly higher in masked hypertensive (8.8 ± 1.6 fL) and essential hypertensive patients (9.1 ± 1.7 fL) than those of normotensive control individuals (7.8 ± 0.8 fL) ($p = 0.01$ and $p = 0.003$, respectively), whereas there was no significant difference between the masked hypertensive and essential hypertensive individuals ($p >0.05$).

Platelet Distribution Width

PDW reflects heterogeneity of platelet volume distribution and is also a marker of platelet activation. Earlier findings have established that raised PDW and MPV levels are an independent risk factor for myocardial infarction including coronary heart diseases^{20,21}. In our study, mean PDW was higher in patients with essential hypertension (13.62 ± 1.30 fL) when compared with normotensive controls (9.94 ± 0.73 fL) and there was a statistically significant difference between the two groups ($p = <0.001$). Ya-GuoZheng *et al*²², found that MPV and PDW were significantly higher in patients with idiopathic pulmonary hypertension than in age and sex-matched control subjects (11.4 ± 0.9 fL v/s 10.3 ± 0.9 fL and $14.3 \pm 2.9\%$ v/s $11.9 \pm 1.9\%$, respectively; $p = 0.000$).

Platelet Count

In our study, the mean platelet count in patients with essential hypertension was 291.02 ± 60.40 per 10^3 /mL and in normotensive controls was 285.88 ± 60.55 per 10^3 /mL which was statistically not significant ($p = 0.343$).

Plateletcrit

In our study, mean plateletcrit was higher in patients with essential hypertension ($0.27 \pm 0.05\%$) when compared with normotensive controls ($0.23 \pm 0.04\%$) and there was a statistically significant difference between the two groups ($p = <0.001$).

Conclusion

We conclude that mean platelet volume, platelet distribution width and plateletcrit are increased in hypertensive patients.

Also, mean platelet volume has linear correlation with grades of hypertension and it can be a predictor of the

grade of hypertension. Hence, assessment of platelet indices may be of vital importance for predicting the occurrence and monitoring the progression of hypertension and its complications; however, long-term, large size, prospective studies are needed to substantiate this conclusion.

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