Original Article

Mean Platelet Volume as a Biomarker of Disease Activity and Therapeutic Response in Urticaria: A Prospective Observational Study

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Abstract

Background: Urticaria is a common inflammatory skin disorder which is characterized by recurrent wheals and angioedema. New evidence suggests that activation of platelets may be involved in its pathogenesis. MPV is a parameter of platelet activation and has been suggested as a possible urticaria inflammatory marker. The goal of this study is to analyse the MPV levels in the patients with urticaria, their association with the duration of urticaria as well as its frequency, and MPV changes after antihistaminic therapy. **Material and Methods:** This was an observational longitudinal study of 138 cases of clinically diagnosed Urticaria, presented in a tertiary care hospital. After thorough clinical evaluation, complete blood count was conducted including estimation of MPVs in an automated hematology analyzer. All patients were treated with conventional antihistaminic drugs and underwent periodic hematological examinations. Pre-treatment and post-treatment MPV were compared and associations with clinical characteristics were analyzed. **Results:** The most frequent sub-type was acute urticaria (60.9%). No statistically significant inter group differences were observed in MPV or platelet count at baseline or after treatment between each urticaria sub-type. However statistically significant reduction within group in MPV were observed in acute urticaria (10.11±1.56 vs. 9.97±1.50 fL; p=0.048) and chronic continuous urticaria (10.34±1.53 vs. 9.08±1.06 fL; p=0.041) after treatment. Overall, MPV decreased significantly from 10.16±1.60 fL to 9.95±1.52 fL after treatment (p=0.041) in entire spectrum of urticaria patients. Platelet counts and other hematological parameters, on the other hand, did not change significantly. **Conclusion:** It was concluded that MPV was significantly reduced after giving antihistaminic therapy, indicating its potential application as a simple, inexpensive biomarker of inflammatory activity and inflammatory response in urticaria patients.

Keywords: Urticaria, MPV; Platelet Activation; Antihistaminic Therapy; Inflammatory Biomarkers; Treatment Response.

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Introduction

Urticaria is a frequent inflammatory skin disease associated with the recurrence of transient wheal formation and/or angioedema, and is triggered by mast cell and basophil activation with release of histamine and other pro-inflammatory mediators. Urticaria can be acute (< 6 weeks) or chronic (≥ 6 weeks) depending on the duration, and it significantly affects the quality of life and places a significant burden on health care systems all over the world.[1] While activating reactions involving mast-cell mediated inflammation are key to the pathogenesis, there is accumulating evidence to suggest that other mechanisms such as coagulation pathways, endothelial dysfunction, and platelet activation play significant roles in contributing to disease activity and persistence.[2]

In the past years, platelets have gained great attention as essential immunomodulatory cells playing significant roles in inflammatory and allergic diseases. In addition to their primary function in hemostasis, platelets release a large number of inflammatory mediators, cytokines, chemokines and platelet-activating factor that are involved in immune responses and vascular inflammation.[3] Average platelet volume as measured by a new automated hematological parameter, mean platelet volume (MPV), is an indicator of platelet activation. The larger platelets are more metabolically and enzymatically active, and have increased pro-inflammatory effects compared to the smaller platelets.[4]

A number of studies have been conducted on MPV in chronic urticaria, but with conflicting results. A few investigators reported that patients with chronic urticaria had significantly elevated MPV levels than healthy controls, indicating the increased activation of platelets and systemic inflammation. [5,6] Other studies, however, have shown a decrease in MPV, suggesting platelet consumption may take place in inflammatory

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sites, complicating the pathogenesis of urticaria.[7] Besides, MPV was found to be associated with disease activity in some patients, suggesting its potential usefulness as a readily accessible indicator of the disease activity.[6,8] Recent research also has shown that inflammatory mediators released from platelets are involved in the persistence of urticaria and in differential responses between antihistaminic therapy.[9,10] Although these observations were made, only limited data exists on alterations of MPV after standard treatment with modern drugs and the correlation between MPV and clinical parameters like duration and frequency of disease. These connections could give more insight on the inflammatory mechanisms involved in the development of urticaria and shed light on some simplified laboratory markers, which help to monitor the treatment response.

This prompted the present study to assess MPV levels in patients with urticaria, investigate any correlation between urticaria duration and MPV, as well as to compare the levels of MPV before and after antihistaminic treatment. This information could help develop MPV as an inexpensive, readily available and clinically useful biomarker to monitor disease activity and therapeutic efficacy in urticaria patients.

Materials and Methods

Study Design and Participants: This is a longitudinal observational study on hospital population where data collection was done in the Department of Dermatology along with Department of Pathology from Teerthanker Mahaveer Medical College & Research Centre (TMMC & RC), Moradabad. This study was started after obtaining approval from the Institutional Ethics Committee and the College Research Committee and continued for 18 months. The study included patients presented with clinical features and diagnosed cases of urticaria in Dermatology OPD. The patients willing to participate and provide blood samples were included in the study. Patients who did not wish to participate or provide blood samples were excluded. The calculated sample size was 138 participants.

History of Present Illness and Physical Examination: A case report form was used to gather detailed clinical history, including physical examination. Venous blood samples for complete blood count analysis were drawn in an aseptic manner in EDTA vacutainer. MPV (fL) was determined by an automated hematology analyzer (BECKMAN COULTER DxH 900, Beckman Coulter, USA). Baseline MPV values were obtained before starting treatment.

Treatment and Follow-Up: All the patients enrolled in this study were treated with the usual antihistaminic medication according to the dermatological treatment plan. Post-treatment follow up with a complete blood count was performed and values of MPVs were again checked. MPV changes after treatment were compared and correlations were performed between the duration and the frequency of urticarial attacks. Statistical Analysis: Statistical software was used to analyze data entered in Microsoft Excel. Data was analyzed and presented as mean (+SD) for continuous variables, and as frequencies (percentages) for categorical variables. Appropriate paired statistical tests were used to compare the pre and post treatment MPVs. Appropriate correlation and comparison was used to examine associations between MPV and clinical characteristics. The results were statistically significant when the p value was less than 0.05.

Results

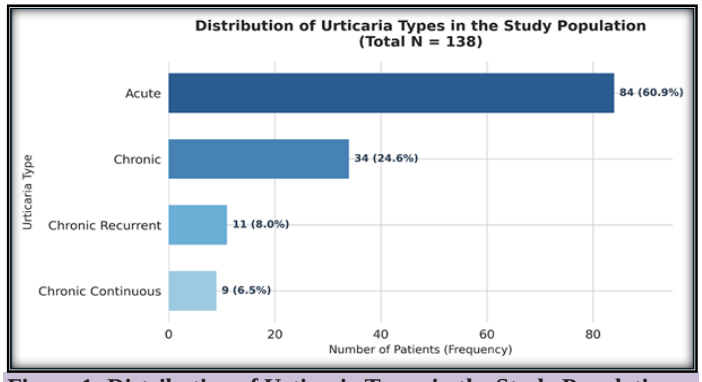

Figure 1: Distribution of Urticaria Types in the Study Population

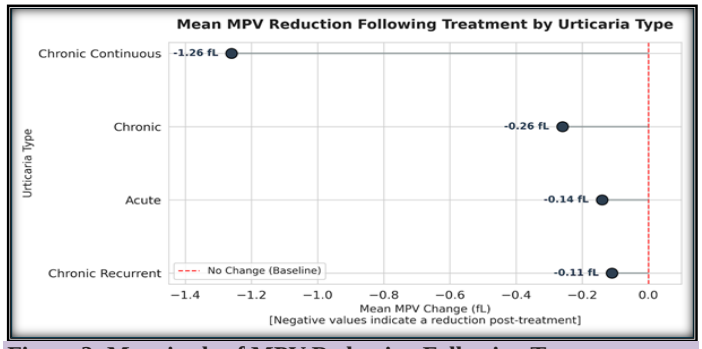

Figure 2: Magnitude of MPV Reduction Following Treatment

Of the total of 138 patients who had clinically diagnosed urticaria, aggregate data on demographic, clinical and hematological profile of the population studied is given in tables 1-5. [Table 1] illustrates that the most prevalent sub-type was acute urticaria (60.9%) followed by chronic urticaria (24.6%), chronic recurrent urticaria (8.0%) and chronic continuous urticaria (6.5%). Although no significant difference was observed in overall sex distribution, male predominance was conspicuously observed in chronic subgroups comprising 90.9% of chronic recurrent urticaria cases and 55.5% of chronic continuous urticaria cases. No significant intergroup differences were found in hemoglobin level and total leukocyte count before or after treatment in urticaria subtypes as presented in [Table 2]. However, eosinophil counts showed a general decline in all categories after treatment. The decrease was particularly visible in chronic recurrent and chronic continuous urticaria subgroups indicating clinical management effectively reduced systemic allergic load in these patients. Platelet parameters, MPV and platelet count before and after treatment are shown in [Table 3]. No statistically significant inter group differences were observed in MPV or platelet count at baseline or after treatment between each urticaria subtype ($p>0.05$ in all). However, these values when compared before and after treatment show reduction in platelet count across all urticaria subtypes except in chronic

continuous urticaria where platelet count was found to be slightly increased compared to pretreatment values. [Table 4] shows paired comparison of MPV before and after treatment according to urticaria subtypes. In acute urticaria and chronic continuous urticaria statistically significant decrease in MPV was observed (p value of 0.048 and 0.041 respectively). Overall MPV decreased from 10.16±1.60 fL to 9.95±1.52 fL after treatment. This reduction in MPV was statistically significant (p=0.041) as shown in [Table 5]. Unlike MPV, platelet count did not demonstrate any significant treatment related change.

The findings are graphically summarized in [Figures 1 and 2]. Urticaria subtypes were distributed as shown in [Figure 1], with acute urticaria being the most common type. [Figure 2] shows the magnitude of MPV decrease after treatment according to disease category and that patients with chronic continuous urticaria showed the greatest decrease.

Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Acute (n=84)	Chronic Recurrent (n=11)	Chronic Continuous (n=9)	Chronic (n=34)
Male, n (%)	39 (46.4)	10 (90.9)	5 (55.6)	16 (47.1)
Female, n (%)	45 (53.6)	1 (9.1)	4 (44.4)	18 (52.9)
Age, years (Mean ± SD)	39.26 ± 19.97	40.00 ± 21.30	49.60 ± 17.76	44.48 ± 15.55
Median Age (Years)	36.5	39.5	51.0	47.0
Age Range (Years)	4–83	9–76	30–72	10–70

Table 2: Hematological Parameters Across Urticaria Subtypes

Parameter	Acute	Chronic Recurrent	Chronic Continuous	Chronic	p-value
Hb Pre (g/dL)	10.79±2.50	9.81±2.84	9.96±2.29	10.70±2.89	0.421
Hb Post (g/dL)	10.82±2.21	9.55±2.67	10.60±2.84	10.43±3.05	0.458
TLC Pre (×10³/µL)	9.05±4.00	9.83±7.48	8.40±4.72	9.66±6.41	0.732
TLC Post (×10³/µL)	9.67±5.84	8.34±3.48	7.70±3.24	8.29±3.04	0.392
Eosinophil % Pre	6.07±3.09	7.40±2.45	6.60±3.50	7.68±3.63	0.058
Eosinophil % Post	5.32±3.49	5.90±5.08	5.60±3.91	6.32±4.26	0.684

Table 3: Platelet Indices According to Urticaria Type

Parameter	Acute	Chronic Recurrent	Chronic Continuous	Chronic	p-value
MPV Pre (fL)	10.11±1.56	9.95±1.77	10.34±1.53	10.34±1.64	0.763
MPV Post (fL)	9.97±1.50	9.84±1.13	9.08±1.06	10.08±1.73	0.211
Platelet Pre (×10³/µL)	215.92±114.36	172.60±96.62	200.60±140.21	200.79±154.36	0.529
Platelet Post (×10³/µL)	210.50±121.01	164.70±109.79	210.80±117.34	200.18±137.36	0.564

Table 4: Paired Analysis of MPV Changes Following Treatment

Disease Category	Pre-MPV (fL)	Post-MPV (fL)	Mean Difference	p-value
Acute	10.11±1.56	9.97±1.50	-0.14	0.048*
Chronic Recurrent	9.95±1.77	9.84±1.13	-0.11	0.312
Chronic Continuous	10.34±1.53	9.08±1.06	-1.26	0.041*
Chronic	10.34±1.64	10.08±1.73	-0.26	0.089

*Statistically significant (p<0.05)

Table 5: Overall Effect of Treatment on Platelet Parameters

Parameter	Pre-treatment	Post-treatment	p-value
MPV (fL)	10.16±1.60	9.95±1.52	0.041*
Platelet Count (×10³/µL)	208.4±128.5	205.7±130.2	0.612

*Statistically significant (p<0.05)

Discussion

The present study was conducted with the aim of assessing MPV in patients of urticaria before and after treatment and to evaluate its relationship with disease duration, frequency and clinical subtypes. The major findings were: (i) the majority of cases were acute urticaria, (ii) baseline MPV was same among the various urticaria subtypes, (iii) significant reductions were seen in MPV after treatment in acute sub-group and in chronic continuous sub-group, and (iv) overall MPV was significantly decreased after therapy in all subtypes, while platelet count did not show any significant reduction.

Acute urticaria (60.9%) registered the greatest number of cases, followed by chronic urticaria (24.6%), chronic recurrent urticaria (8.0%) and chronic continuous urticaria (6.5%). No significant difference was observed in overall sex distribution. This is in close agreement with the epidemiological findings reported by Gómez et al,[11] and Godse et al,[2] about urticaria being a frequent dermatological disease in general population in both genders and age groups. Like Sánchez et al,[7] reported, these differences in the presentation of the disease and/or its course indicate significant heterogeneity amongst those suffering from chronic urticaria, which was what was seen in our group.

The mean ages of the patients varied between 39.3 years in acute urticaria and 49.6 years in chronic continuous urticaria. In these patients age at disease onset may indicate more advanced immune dysregulation and chronic inflammation. This finding

coincides with those shown by Gómez et al,[11] and Sánchez et al,[7] who pointed to the chronic phase of urticaria being more common in - middle age adults and a prolonged course being observed.

The present study observed no significant difference in 'hemoglobin level', 'total leucocyte count' and 'differential leucocyte count' between different urticaria subtypes. The results indicate that classical hematological parameters do not necessarily represent disease status in urticaria. In today's research, the focus has shifted to identifying blood inflammatory markers, with fewer studies focused on traditional blood markers associated with inflammation. Kulumbegov et al,[3] showed that the levels of certain cytokines correlated more closely with disease activity than with the standard blood counts.

This study was largely centered on MPV, as a marker of platelet activation and systemic inflammation. There was no significant difference between the different urticaria subtypes with regard to the baseline MPV values. Post treatment analysis showed significant decrease in MPV in patients with acute urticaria and chronic continuous urticaria subtypes and a significant decrease in MPV overall urticaria patients. This study was in line with the above hypothesis and led to the findings that inflammation through platelet activation is a part of urticaria pathogenesis and successful treatment can have a modulatory effect on inflammation. Platelets are more active in immune and inflammatory processes and there has been increasing evidence of their role to them in recent years. Larenas-Linnemann,[5] noted that inflammatory biomarkers specific for autoimmune chronic urticaria could be used to monitor disease activity and response to treatment. Likewise, Gimenez-Arnau et al,[8] addressed the importance of laboratory markers of inflammatory burden as predictors of the outcome of urticaria treatment. This decrease in MPV seen in our study following antihistaminic therapy may, therefore, be a quantifiable decrease in the inflammatory and platelet activation status after the disease is controlled.

The marked reduction in MPV after the treatment in the presence of relatively fixed platelet counts is noteworthy. This means that in addition to platelet counts, platelet volume and platelet activation could be used as more sensitive markers of disease activity. The idea of using biomarkers for disease monitoring and therapeutic decision making was suggested by Xiang et al.[9] Our results indicate that MPV may serve as a simple, an inexpensive and an available marker of treatment response.

The decrease in MPV after treatment is also in line with the current knowledge on the pathogenesis of urticaria. Chronic spontaneous urticaria has been defined by Kaplan,[10] as a "mast-cell-mediated inflammatory condition with complex mechanisms not limited to histamine release". In a similar nature, Kolkhir et al,[6] pointed out that – at the current stage – therapeutic strategies aim at wider inflammatory networks and mechanisms of immune activation. The decreases in platelet activation markers (MPV) observed in the present study might be expected as inflammation resolves with therapy. Several immune-regulatory genes and inflammatory pathways were found to be linked to chronic urticaria by Su et al,[4] and elevated inflammatory mediators were shown among affected individuals by Kulumbegov et al.[3] The studies collectively indicate that inflammatory activation is a phenomenon wider than mast cell activation, and it is also evoking other components, such as platelets. The marked decrease in MPV seen in our study may thus be associated with a decrease in systemic inflammatory activity after treatment.

There is a current international and national consensus that one important priority is to develop objective measures that can measure disease activity and treatment response. The introduction of practical laboratory parameters in management of urticaria will supplement the clinical assessment as highlighted by Zuberbier et al,[1] and Godse et al.[2] While not routinely monitored, our results also indicate that MPV might be useful as an adjunct module in disease monitoring, especially in resource-limited settings, where state-of-the-art immunological tests are not widely available.

Limitations: This present study comes with a few limitations. First, it was done in a single tertiary care hospital, potentially reducing the generalization of the results. Second, the study failed to have a healthy control group to directly compare the MPV values in the subjects. Third, no attempt was made to incorporate some of the scoring systems for severity of disease including Urticaria Activity Score (UAS7) to correlate MPV with clinical disease activity. Moreover, other inflammatory markers, such as C-reactive protein, D-dimer, interleukins, and platelet activation markers were not determined. To further elucidate the role of MPV as a biomarker of disease activity and therapeutic response in urticaria, multicenter studies with larger patient populations and more extensive biomarker profiling are warranted in the future.

Conclusion

This current research shows that mean platelet volume (MPV), an easily accessible indicator of platelet activation and systemic inflammation, significantly drops after using antihistaminic drugs in urticaria patients, especially for patients with acute and chronic continuous subtypes. Treatment-related changes in the hemoglobin level, total leukocyte count and platelet count were not significant, but MPV was, indicating its potential as a biomarker of disease activity and therapeutic efficacy. Overall, these results lead to the possible idea that inflammatory processes mediated by platelets may play a role in the pathogenesis of urticaria and suggest that MPV may represent a low-cost, easily available supplemental diagnostic tool to evaluate the therapeutic response in the future in clinical routine. It needs to be validated in further multicenter studies with the inclusion of disease severity indices and other inflammatory markers in order to establish its predictive and clinical value.

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Conflicts of interest

There are no conflicts of interest.

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