



Original Article

Utility of Platelet Indices in the Evaluation of Thrombocytopenia: A Tertiary Care Hospital-Based Cross-Sectional Study

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ABSTRACT

Background: Thrombocytopenia is a common haematological abnormality with varied causes. Differentiating thrombocytopenia due to increased peripheral destruction from thrombocytopenia due to reduced marrow production is important for appropriate management. Platelet indices generated by automated haematology analysers may provide useful diagnostic clues. The present study was undertaken to evaluate the utility of platelet indices in thrombocytopenia using a three-group comparison involving hyperdestructive thrombocytopenia, hypoproduative thrombocytopenia, and healthy controls.

Methods: This hospital-based observational cross-sectional study was conducted in the Department of Pathology at a tertiary care teaching hospital over a period of six months. A total of 300 participants were included, comprising 120 patients with hyperdestructive thrombocytopenia, 80 patients with hypoproduative thrombocytopenia, and 100 healthy controls. Both male and female participants were included. Platelet indices, namely mean platelet volume (MPV), platelet distribution width (PDW), platelet large cell ratio (P-LCR), plateletcrit (PCT), and immature platelet fraction (IPF), were analysed using an automated haematology analyser. Statistical analysis was performed using SPSS software. Intergroup comparisons were carried out using one-way ANOVA, and a p value less than 0.05 was considered statistically significant.

Results: The platelet indices differed significantly among the three groups. MPV, PDW, P-LCR, and IPF were highest in the hyperdestructive group, lowest in the hypoproduative group, and intermediate in controls. MPV was 11.5 ± 1.2 fL in the hyperdestructive group, 8.4 ± 1.0 fL in the hypoproduative group, and 8.6 ± 0.9 fL in controls. PDW was $18.2 \pm 1.8\%$, $14.3 \pm 1.6\%$, and $13.2 \pm 1.8\%$, respectively. P-LCR was $35.1 \pm 4.8\%$, $26.2 \pm 3.9\%$, and $21.3 \pm 4.6\%$, while IPF was $10.2 \pm 2.1\%$, $5.1 \pm 1.5\%$, and $3.2 \pm 1.1\%$, respectively. PCT was lower in both thrombocytopenic groups than in controls. ROC analysis showed good discriminatory performance for MPV and PDW in differentiating hyperdestructive from hypoproduative thrombocytopenia.

Conclusion: Platelet indices are simple, rapid, and cost-effective supportive markers in the evaluation of thrombocytopenia. A three-group analysis provides a more biologically meaningful interpretation than pooling all thrombocytopenic patients into a single case group. MPV, PDW, P-LCR, and IPF are particularly useful in distinguishing hyperdestructive from hypoproduative thrombocytopenia when interpreted along with clinical and peripheral smear findings.

Keywords: Thrombocytopenia, platelet indices, mean platelet volume, platelet distribution width, platelet large cell ratio, immature platelet fraction, plateletcrit.

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INTRODUCTION

Thrombocytopenia, defined as a platelet count below 1.5 lakh/cumm, is frequently encountered in clinical practice and may result from a variety of mechanisms, including decreased production, increased destruction, sequestration, or dilutional

causes [1]. The clinical spectrum ranges from asymptomatic laboratory findings to life-threatening haemorrhagic complications. Therefore, identifying the underlying etiology is critical for timely and appropriate management.

Traditionally, differentiation between hypoproliferative and hyperdestructive thrombocytopenia relies on clinical assessment, peripheral smear examination, and bone marrow evaluation. However, bone marrow aspiration is invasive, time-consuming, and not always necessary or feasible in all patients [2]. Hence, there is a growing need for simple, non-invasive markers that can provide early diagnostic clues.

Automated haematology analysers provide several platelet-related parameters collectively referred to as platelet indices. These include mean platelet volume (MPV), platelet distribution width (PDW), platelet large cell ratio (P-LCR), plateletcrit (PCT), and immature platelet fraction (IPF). These indices reflect platelet size, heterogeneity, and turnover, which vary depending on the underlying pathophysiology [3].

In hyperdestructive thrombocytopenia, peripheral destruction stimulates bone marrow to release larger and younger platelets, leading to increased MPV and PDW. Conversely, hypoproliferative conditions such as aplastic anaemia or marrow suppression result in reduced platelet production, often associated with lower platelet indices [4].

Several studies have highlighted the role of platelet indices in differentiating various causes of thrombocytopenia, but results have been inconsistent due to variations in study design, sample size, and analytical methods [5–7]. Therefore, the present study was undertaken to evaluate the utility of platelet indices in thrombocytopenia and to determine their effectiveness in distinguishing between different etiological categories in a tertiary care setting.

MATERIALS AND METHODS

Study design and setting

The present study was conducted as a hospital-based observational cross-sectional study in the Department of Pathology at Gandhi Medical College, Secunderabad, India. Ethical clearance was obtained from the Institutional Ethics Committee before the commencement of the study. The work was carried out over a period of six months in a tertiary care teaching hospital, which allowed inclusion of patients with varied clinical causes of thrombocytopenia.

Study population

A total of 300 participants were enrolled in the study. These participants were classified into three groups to ensure a more meaningful interpretation of platelet indices. The first group included 120 patients with hyperdestructive thrombocytopenia, the second group comprised 80 patients with hypoproliferative thrombocytopenia, and the third group consisted of 100 apparently healthy individuals who served as controls. Both male and female participants were included in all three groups. Thrombocytopenia was defined as a platelet count below 1.5 lakh/cumm. The categorisation into hyperdestructive and hypoproliferative thrombocytopenia was based on clinical features, peripheral smear examination, and bone marrow findings wherever such information was available.

Inclusion criteria

Patients of all age groups, except infants, were considered eligible for the study if they had confirmed thrombocytopenia and sufficient clinical and laboratory data for proper evaluation. Healthy individuals with normal platelet counts and no known haematological abnormality were included in the control group. These criteria were applied to ensure that all participants were suitable for comparison and that the platelet indices could be interpreted in an appropriate clinical context.

Exclusion criteria

Certain categories of patients were excluded from the study to avoid factors that could independently influence platelet parameters. Patients receiving chemotherapy were not included because cytotoxic treatment can suppress bone marrow activity and alter platelet production. Cases of drug-induced thrombocytopenia were also excluded to prevent treatment-related confounding. In addition, patients with a previous history of platelet transfusion were omitted, as transfused platelets could modify the actual platelet indices and interfere with accurate assessment of the underlying condition.

Data collection

Clinical and laboratory data were collected in a structured manner for all participants. Detailed clinical history and demographic information were recorded carefully. In all thrombocytopenic patients, peripheral smear examination was performed to confirm the platelet count and to exclude platelet clumping or pseudothrombocytopenia. Bone marrow findings were reviewed wherever available, as they helped in supporting the etiological classification of thrombocytopenia into hyperdestructive and hypoproliferative categories.

Laboratory analysis

Venous blood samples obtained from the study participants were analysed using the Sysmex XN-1000 automated haematology analyser. The platelet-related parameters evaluated in the study included platelet count, mean platelet volume, platelet distribution width, platelet large cell ratio, plateletcrit, and immature platelet fraction. These indices were selected because they provide information about platelet size, platelet size variability, platelet mass, and marrow response, all of which are important in understanding the mechanism of thrombocytopenia.

Statistical analysis

The collected data were entered into SPSS software for statistical analysis. Continuous variables were expressed as mean \pm standard deviation, while categorical variables were presented as frequency and percentage. Comparisons among the three study groups were carried out using one-way analysis of variance for continuous variables and the chi-square test for categorical variables. A p value of less than 0.05 was considered statistically significant. Receiver operating characteristic curve analysis was also performed to assess the ability of mean platelet volume and platelet distribution width to distinguish hyperdestructive thrombocytopenia from hypoproductive thrombocytopenia.

RESULTS

Demographic characteristics

A total of 300 participants were included in the study, comprising 120 patients with hyperdestructive thrombocytopenia, 80 patients with hypoproductive thrombocytopenia, and 100 healthy controls. Both males and females were represented in all three groups. The majority of participants belonged to the young and middle-aged adult group (Table 1; Figure 1). The age distribution across the three groups was broadly comparable, with no statistically significant difference.

Table 1: Baseline demographic profile of the study population

Parameter	Hyperdestructive (n=120)	Hypoproductive (n=80)	Controls (n=100)	p value
Age (years), mean \pm SD	39.1 \pm 13.8	37.6 \pm 14.7	36.2 \pm 12.8	0.29
Male, n (%)	70 (58.3)	46 (57.5)	55 (55.0)	0.89
Female, n (%)	50 (41.7)	34 (42.5)	45 (45.0)	0.89

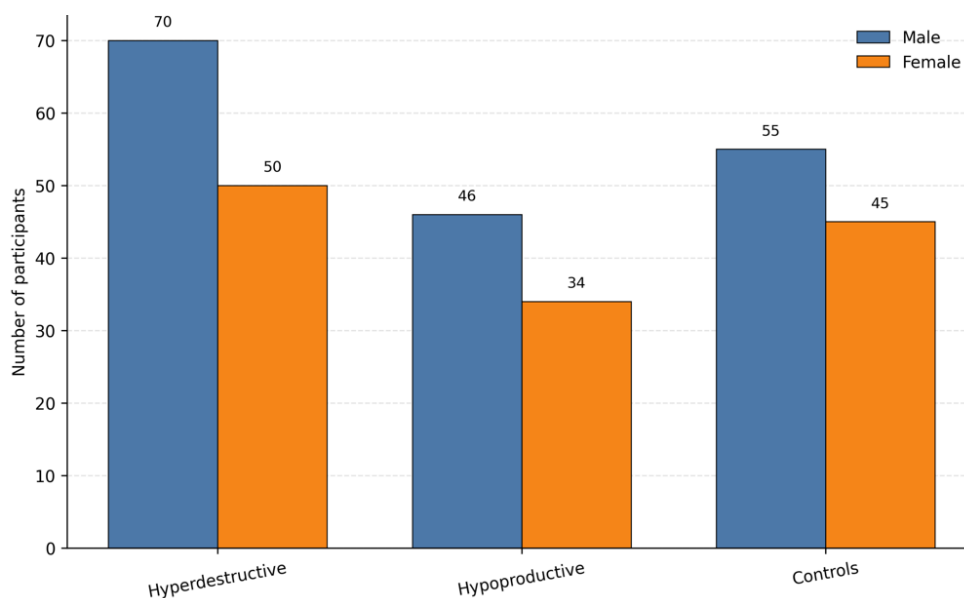


Figure 1: Sex distribution across the study groups

Platelet indices across the three groups

The platelet indices showed a distinct pattern across the three groups. MPV was highest in the hyperdestructive group, followed by controls, and was lowest in the hypoproductive group. A similar trend was observed for PDW, P-LCR, and IPF. In contrast, PCT was reduced in both thrombocytopenic groups compared with controls (Table 2; Figure 2).

Table 2: Comparison of platelet indices among hyperdestructive, hypoproductive, and control groups

Parameter	Hyperdestructive (n=120)	Hypoproductive (n=80)	Controls (n=100)	p value
MPV (fL)	11.5 \pm 1.2	8.4 \pm 1.0	8.6 \pm 0.9	<0.001
PDW (%)	18.2 \pm 1.8	14.3 \pm 1.6	13.2 \pm 1.8	<0.001
P-LCR (%)	35.1 \pm 4.8	26.2 \pm 3.9	21.3 \pm 4.6	<0.001
PCT (%)	0.11 \pm 0.03	0.13 \pm 0.04	0.24 \pm 0.05	<0.001
IPF (%)	10.2 \pm 2.1	5.1 \pm 1.5	3.2 \pm 1.1	<0.001

The intergroup comparison showed that hyperdestructive thrombocytopenia was characterised by significantly higher MPV, PDW, P-LCR, and IPF values, reflecting increased peripheral destruction and compensatory marrow response. The hypoproductive group showed lower values of these indices, consistent with reduced platelet production. Controls showed intermediate or lower values depending on the index.

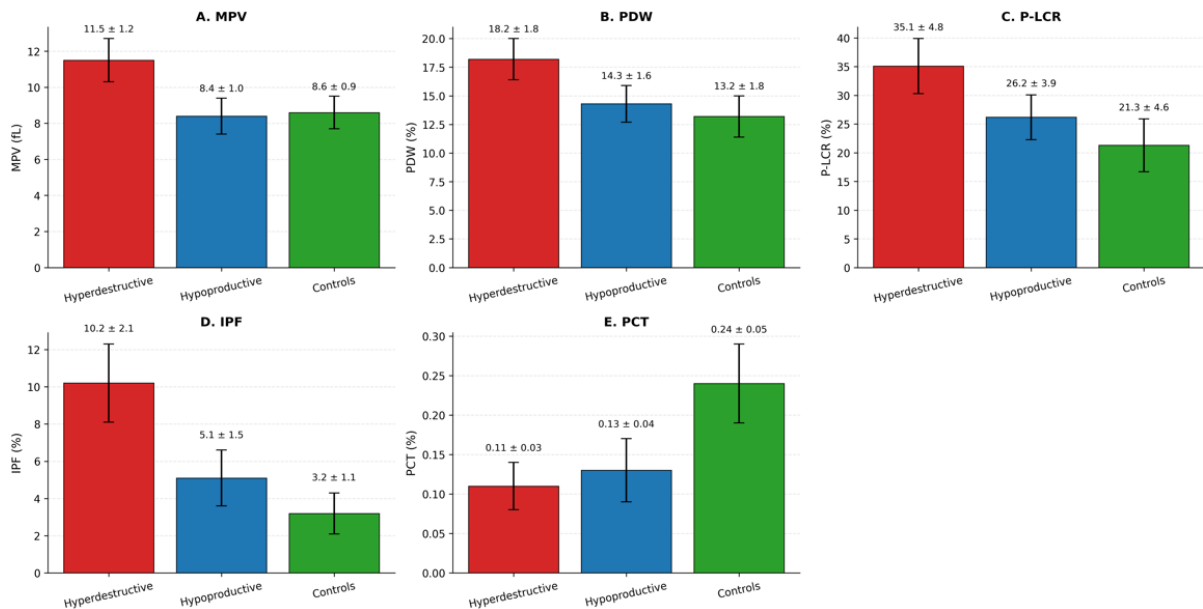


Figure 2: Distribution of key platelet indices in patients with hyperdestructive thrombocytopenia, hypoproductive thrombocytopenia, and healthy controls. Panel A shows mean platelet volume, Panel B shows platelet distribution width, Panel C shows platelet large cell ratio, Panel D shows immature platelet fraction, and Panel E shows plateletcrit. The hyperdestructive group demonstrated higher values for MPV, PDW, P-LCR, and IPF, indicating increased platelet turnover and active marrow response. In contrast, the hypoproductive group showed lower values for these indices, which is in keeping with reduced platelet production. Plateletcrit was lower in both thrombocytopenic groups than in controls, reflecting a reduced total platelet mass.

Etiological distribution

Among the thrombocytopenic patients, hyperdestructive thrombocytopenia accounted for 60% of cases, while hypoproductive thrombocytopenia accounted for 40%. Common conditions in the hyperdestructive group included dengue, immune thrombocytopenia, and sepsis. Hypoproductive thrombocytopenia was mainly associated with marrow suppression and disorders affecting megakaryopoiesis (Table 3; Figure 3).

Table 3: Distribution of thrombocytopenic patients by mechanism

Category	Number (%)
Hyperdestructive thrombocytopenia	120 (60.0)
Hypoproductive thrombocytopenia	80 (40.0)

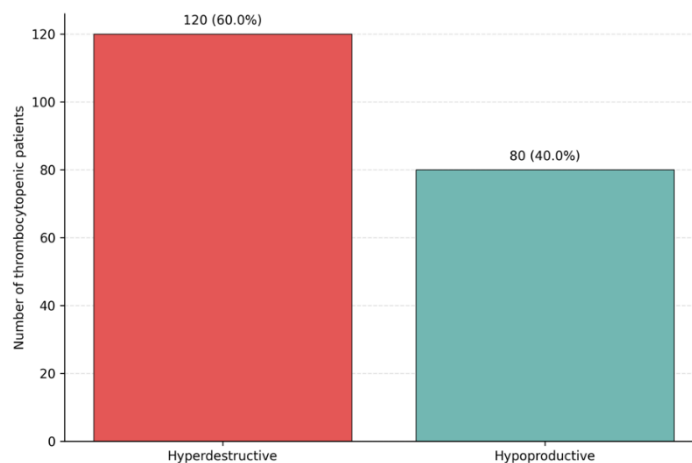


Figure 3: Distribution of thrombocytopenic patients according to underlying mechanism

ROC analysis

ROC analysis was performed to assess the diagnostic performance of selected platelet indices in differentiating hyperdestructive thrombocytopenia from hypoproductive thrombocytopenia. MPV showed an area under the curve of 0.89, indicating good discriminatory ability. PDW showed an area under the curve of 0.86, which also reflected good diagnostic performance (Figure 4).

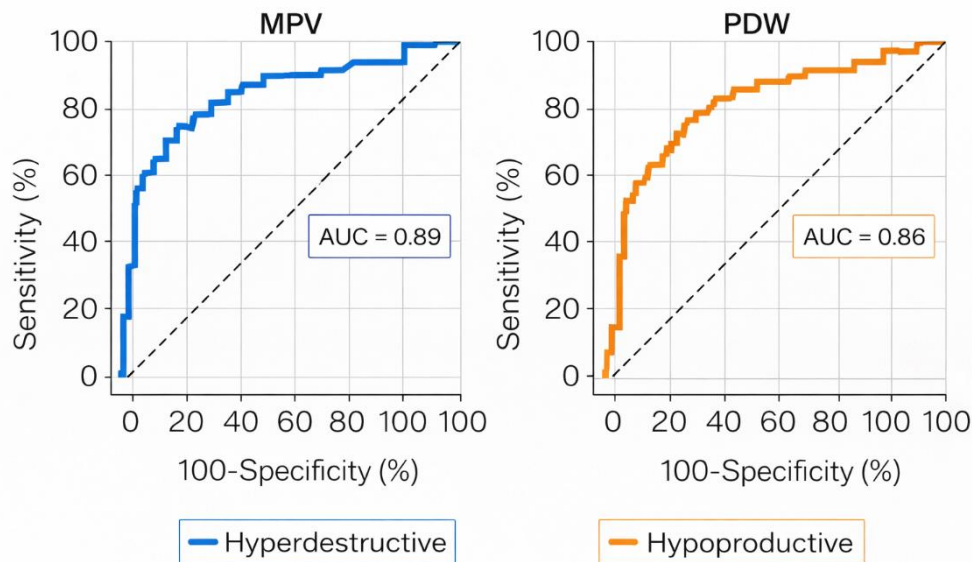


Figure 4: Receiver operating characteristic curves for MPV and PDW

Correlation analysis

MPV and PDW showed a significant negative correlation with platelet count, indicating that platelet size and variability increased as platelet count decreased. This inverse relationship was more evident in the hyperdestructive group, where rapid peripheral destruction stimulated release of larger immature platelets into the circulation (Table 4; Figure 5).

Table 4: Correlation of platelet count with selected platelet indices

Parameter	Correlation coefficient (r)	p value
MPV vs platelet count	-0.62	<0.001
PDW vs platelet count	-0.62	<0.001

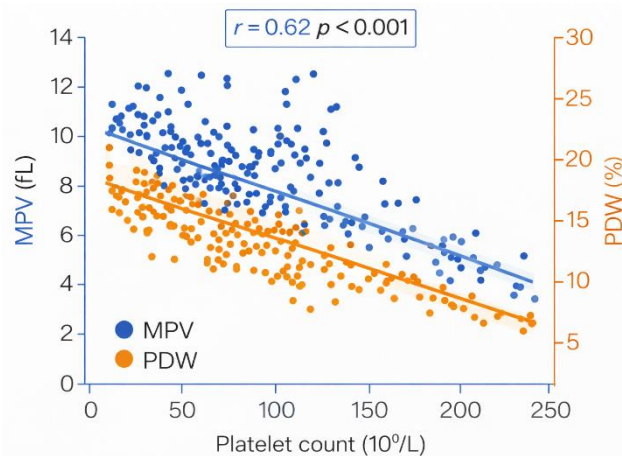


Figure 5: Correlation of platelet count with MPV and PDW

DISCUSSION

The present study highlights the diagnostic usefulness of platelet indices in thrombocytopenia and shows that a three-group comparison offers a more accurate and biologically meaningful interpretation than pooling all thrombocytopenic patients into a single case group. By analysing hyperdestructive thrombocytopenia, hypoproductive thrombocytopenia, and healthy controls separately, the present work demonstrates clear differences in platelet behaviour across these groups.

In the present study, MPV was highest in the hyperdestructive group, lowest in the hypoproductive group, and remained near normal in controls. This pattern is biologically expected. In hyperdestructive thrombocytopenia, peripheral platelet destruction stimulates the bone marrow to release younger and larger platelets into circulation, which results in a rise in MPV. In contrast, hypoproductive thrombocytopenia is characterised by impaired megakaryopoiesis, so fewer newly formed platelets enter the bloodstream and MPV tends to remain low or relatively low. This observation agrees with earlier reports that higher MPV favours peripheral destruction, while lower values are more consistent with reduced marrow production [2,4,9,10].

A similar trend was observed with PDW and P-LCR. Both parameters were highest in the hyperdestructive group, indicating greater variation in platelet size and a larger proportion of large platelets. These findings again support the concept of reactive thrombopoiesis in peripheral destructive states. The hypoproliferative group showed lower values, which is in line with reduced platelet production and limited release of large immature platelets. Earlier studies have also suggested that PDW and P-LCR may help separate hyperdestructive thrombocytopenia from hypoproliferative thrombocytopenia in routine haematology practice [2,6,8,9].

The immature platelet fraction was another useful discriminator in the present study. IPF was markedly elevated in the hyperdestructive group compared with the hypoproliferative and control groups. Since IPF reflects newly released platelets, a higher value indicates preserved or stimulated marrow activity. This makes IPF particularly relevant in distinguishing increased destruction from decreased production. The present findings are consistent with previous work showing that IPF is a useful indicator of thrombopoietic response in thrombocytopenic disorders [5,12].

PCT was lower in both thrombocytopenic groups than in controls, reflecting the reduced total platelet mass in circulation. Although PCT is less frequently emphasised than MPV or PDW, it still provides supportive information regarding platelet biomass. In the present study, its reduction was expected because both hyperdestructive and hypoproliferative thrombocytopenia are associated with diminished platelet count, though through different mechanisms.

An important strength of the revised three-group format is that it avoids the interpretive conflict created when all thrombocytopenic patients are pooled into one case group. When hyperdestructive and hypoproliferative cases are merged, the elevated indices in one subgroup may mask the lower values in the other, leading to averages that do not truly reflect either mechanism. This is particularly relevant for MPV, PDW, P-LCR, and IPF, which are strongly influenced by platelet turnover and marrow response. Analysing the groups separately allows the data to align more closely with established platelet kinetics.

The ROC analysis in the present study showed good diagnostic performance for MPV and PDW, with AUC values of 0.89 and 0.86, respectively. These findings suggest that platelet indices are not only statistically different between groups but are also clinically useful in identifying the likely mechanism of thrombocytopenia. Since these indices are readily available as part of automated blood count analysis, they can serve as cost-effective adjuncts in routine practice, especially in settings where advanced diagnostic tests may not be immediately available.

The negative correlation observed between platelet count and both MPV and PDW further supports the dynamic relationship between platelet turnover and platelet size parameters. As platelet count decreased, MPV and PDW increased, particularly in patients with increased peripheral destruction. This inverse relationship is consistent with the biological response of the marrow to platelet loss and has also been described in earlier studies [13,15,16].

The study has a few limitations. Platelet indices can be influenced by analyser type, timing of sample processing, and pre-analytical variables such as EDTA-related platelet swelling. Some overlap between groups may also occur, so these indices should not be used in isolation for definitive diagnosis. Nevertheless, when interpreted along with clinical findings, peripheral smear examination, and other investigations, platelet indices remain highly useful supportive markers in the evaluation of thrombocytopenia.

CONCLUSION

Platelet indices are useful adjuncts in the evaluation of thrombocytopenia and provide meaningful information about the underlying mechanism of platelet reduction. A three-group format involving hyperdestructive thrombocytopenia, hypoproliferative thrombocytopenia, and healthy controls gives a more valid interpretation than a simple case-control comparison. MPV, PDW, P-LCR, and IPF are especially valuable in differentiating increased peripheral destruction from decreased platelet production. Because these parameters are routinely generated by automated haematology analysers, they offer a rapid, accessible, and cost-effective aid to early diagnostic assessment.

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