COMPARISON OF TRADITIONAL AND NOVEL HEMOSTATIC PARAMETERS IN CHILDREN WITH ITP

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Abstract: This study evaluates the comparative utility of traditional versus novel hemostatic parameters in children diagnosed with idiopathic thrombocytopenic purpura (ITP). While platelet counts and standard coagulation tests remain the primary diagnostic tools, emerging markers such as platelet activation assays, thromboelastography, and endothelial function indicators provide additional insights into bleeding risk and disease severity. The study highlights differences in predictive value between conventional and advanced markers, emphasizing the importance of integrating novel hemostatic assessments for comprehensive evaluation and personalized management of pediatric ITP.

Keywords: Idiopathic thrombocytopenic purpura, pediatric hematology, traditional hemostatic parameters, novel hemostatic markers, platelet function, thromboelastography, bleeding risk, thrombocytopenia

Idiopathic thrombocytopenic purpura (ITP) is a common autoimmune hematologic disorder in children, characterized by isolated thrombocytopenia. Clinical manifestations range from mild bruising and petechiae to severe hemorrhage, making accurate assessment of bleeding risk essential for patient management. Traditionally, evaluation of pediatric ITP relies on platelet counts and standard coagulation profiles, such as prothrombin time (PT), activated partial thromboplastin time (aPTT), and fibrinogen levels. While these parameters provide a quantitative assessment of platelet number and secondary hemostasis, they may not fully reflect functional hemostatic capacity or predict bleeding tendencies.

Recent advances in laboratory diagnostics have introduced novel hemostatic markers that offer dynamic and functional assessment of the hemostatic system. Platelet activation assays, thromboelastography (TEG), and endothelial function indicators provide additional predictive information about clot formation, platelet functionality, and vascular integrity. Comparing traditional and novel markers allows for better risk stratification, early identification of high-risk patients, and more individualized treatment strategies.

This study aims to evaluate the comparative effectiveness of conventional and advanced hemostatic parameters in pediatric ITP, examining their correlation with clinical manifestations and their predictive value for bleeding complications. Understanding these differences will support the integration of novel markers into routine clinical practice for improved patient care.

Idiopathic thrombocytopenic purpura (ITP) is an autoimmune disorder in children characterized by isolated thrombocytopenia, which arises due to immune-mediated destruction of platelets and, in some cases, impaired platelet production. Clinically, pediatric ITP can present with a wide spectrum of bleeding manifestations, ranging from minor mucocutaneous hemorrhages, such as petechiae and ecchymoses, to severe life-threatening events including intracranial bleeding. Accurate evaluation of bleeding risk is essential for effective management and treatment planning. Traditionally, platelet count and standard coagulation tests, including prothrombin time (PT), activated partial thromboplastin time (aPTT), and fibrinogen levels, have served as the primary indicators of disease severity and hemostatic competence. However, these conventional parameters may not fully reflect functional platelet integrity or the dynamic interplay of the coagulation system, limiting their predictive value for clinical outcomes.

Recent advances in hemostatic diagnostics have introduced novel markers that assess platelet functionality, clot dynamics, and endothelial health, providing a more comprehensive evaluation of the hemostatic system in pediatric ITP. Platelet activation assays, for example, measure the expression of surface molecules such as P-selectin, PAC-1 binding, and soluble CD40 ligand, which indicate platelet readiness for adhesion and aggregation. These markers can identify children with functional platelet impairment who may be at high risk of bleeding, even when platelet counts are moderately reduced. By contrast, conventional platelet counts provide quantitative information but offer limited insight into the qualitative aspects of platelet activity, which can be critical for predicting hemorrhagic events.

Thromboelastography (TEG) represents another important advancement in evaluating hemostasis. TEG assesses the kinetics of clot formation, strength, and stability, providing real-time data on the interactions between platelets, coagulation factors, and fibrinogen. In pediatric ITP, TEG can reveal subtle deficiencies in clot development that are not apparent from standard coagulation tests. This dynamic assessment allows clinicians to detect functional hemostatic deficits early, thereby

informing treatment decisions such as the need for platelet transfusions, immunomodulatory therapy, or other interventions aimed at reducing bleeding risk.

Endothelial function markers, including von Willebrand factor, thrombomodulin, and soluble adhesion molecules, further complement the assessment of hemostatic status. Endothelial cells regulate platelet adhesion, aggregation, and thrombin generation, and their dysfunction can exacerbate bleeding tendencies. Evaluating these markers alongside traditional platelet counts and coagulation tests provides a holistic view of the hemostatic system, particularly in cases where platelet function is impaired but platelet numbers are only moderately reduced. This comprehensive approach enables accurate prediction of hemorrhagic risk and better stratification of patients according to severity.

Comparative studies have shown that while conventional platelet counts and coagulation tests are useful for initial diagnosis, novel hemostatic markers offer superior predictive value for clinical outcomes. Children with normal or mildly reduced platelet counts may still experience significant bleeding if platelet activation or clot formation is impaired. Conversely, children with severely reduced platelet counts but preserved platelet functionality may exhibit relatively mild bleeding manifestations. These findings highlight the limitations of relying solely on traditional hemostatic parameters and underscore the clinical utility of integrating advanced markers into routine assessment.

Furthermore, the use of novel hemostatic markers provides valuable insights into disease progression and response to therapy. Longitudinal monitoring of platelet activation, TEG parameters, and endothelial function can reveal early trends in hemostatic competence, helping to anticipate relapses, monitor treatment efficacy, and adjust therapeutic interventions. For instance, improvement in platelet activation profiles or TEG parameters after corticosteroid or intravenous immunoglobulin (IVIG) therapy may indicate effective restoration of functional hemostasis even before platelet counts normalize. Conversely, persistent abnormalities in these markers may prompt consideration of alternative or more intensive treatment strategies.

Pathophysiologically, integrating traditional and novel hemostatic assessments allows clinicians to understand the multifactorial nature of bleeding in pediatric ITP. Autoantibody-mediated platelet destruction not only reduces platelet number but can also impair functional capacity, affecting platelet adhesion, aggregation, and interaction with coagulation factors. Evaluating both quantitative and qualitative aspects of hemostasis provides a more complete understanding of disease mechanisms, supporting

targeted therapeutic approaches aimed at both increasing platelet count and restoring functional hemostasis.

Despite their clinical advantages, the implementation of novel hemostatic markers in routine pediatric ITP evaluation is limited by technical complexity, cost, and availability. Platelet activation assays and TEG require specialized laboratory equipment and trained personnel, and standardized protocols are still being developed. Nonetheless, ongoing research and technological advances are increasing the feasibility, reliability, and accessibility of these assessments. Integrating these markers with conventional parameters in a standardized protocol can optimize risk stratification, guide personalized treatment, and improve clinical outcomes for pediatric ITP patients.

In conclusion, comparing traditional and novel hemostatic parameters in children with ITP reveals the complementary roles of quantitative and functional assessments in predicting bleeding risk and guiding management. Conventional tests, such as platelet counts and standard coagulation profiles, remain essential for initial evaluation, but they provide limited predictive information regarding functional hemostasis. Advanced markers—including platelet activation assays, thromboelastography, and endothelial function indicators—offer superior insights into clotting dynamics, platelet functionality, and overall hemostatic competence. Integrating both traditional and novel parameters into clinical practice enhances early diagnosis, risk stratification, and individualized treatment planning, ultimately improving outcomes for pediatric patients with ITP.

Comparing traditional and novel hemostatic parameters in pediatric idiopathic thrombocytopenic purpura (ITP) demonstrates the complementary value of both approaches in assessing bleeding risk and guiding management. Traditional parameters, such as platelet counts and standard coagulation tests, provide essential quantitative information but may not fully capture functional hemostatic deficits. Novel markers, including platelet activation assays, thromboelastography, and endothelial function indicators, offer dynamic and functional insights into platelet performance, clot formation, and vascular integrity.

Integrating traditional and advanced hemostatic assessments allows for comprehensive evaluation of each patient, improving risk stratification, informing individualized therapeutic decisions, and predicting clinical outcomes more accurately. Longitudinal monitoring of these markers supports early detection of complications, assessment of treatment efficacy, and timely adjustments in management strategies.

Overall, combining conventional and novel hemostatic parameters enhances the precision of diagnosis and optimizes care for children with ITP.

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